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19FEB04 E874455-1 D10081
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Request for grant of a Patent

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1.	Your reference	BEC/M2966-00001 18 FEB 2004
2.	Patent application number	
3.	Full name, address and postcode of the or each applicant Patents ADP Number If the applicant is a corporate body, give the country/state of incorporation	MURFIN, Quintin Anthony Rosewood La Longue Rue St Martin Jersey JE3 6ED Channel Islands 8727760001 England & Wales
4.	Title of Invention	Sustainable Surface Water Disposal System
5.	Name of agent Address for service in the United Kingdom to which all correspondence should be sent Patents ADP number *(if you know it)*	**Nabarro Nathanson** Lacon House Theobald's Road London WC1X 8RW 05768304002
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and the or each application number	Country · Priority Application number · Date of filing
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and filing date of the earlier application	Number of earlier application · Date of filing
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request?	No
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Drawing	2 & 2
10. If you are also filing any of the following, state how many against each item.	
Priority documents	N/A
Translations of priority documents	N/A
Statement of Inventorship	N/A
Request for search 9/77	1
Request for examination 10/77	1
Any other documents	Fee Sheet
	I/We request the grant of a patent on the basis of this application
Signature	
Name	**Nabarro Nathanson** **Agent for the Applicant**
Date	18 February, 2004
Name and daytime telephone number of person to contact	Richard Williams 0207 524 6959

Sustainable Surface Water Disposal System

Background of the Invention

The present invention relates to sustainable surface water drainage. Sustainable urban drainage systems (SUDS) is a term that that refers to drainage systems that are environmentally sustainable rather than those which require the removal and remote treatment of large quantities of water using sewers and treatment works. Typical such devices are swales and infiltration basins.

The objective of SUDS is to reduce the volume of surface water requiring disposal to the adjoining aquatic environment. This reduces the requirement for improvements to the watercourses and culverts downstream to prevent flooding of the environment.

The need for SUDS arises when large surface areas are paved, such as by roads, car parks, airports, distribution centres and the like. These paved surfaces are described herein as pavements. They are normally required to be load bearing.

Technical Problems

Paving over areas can cause an increased flooding risk. There is usually an increased runoff rate from a pavement compared to a vegetated surface and this increase in runoff can increase the risk of flooding at periods of high rainfall intensity within the receiving catchment. Flooding risks also increase when pavements are subject to the deposit of large amounts of water within a short period as in storm conditions or at fire service training grounds or where vehicles are washed.

Pollution of the aquatic environment by water drained from pavements is also a problem. Many pavements are subject to the deposition of pollution. Pavements for vehicles, for example road carriageways, car parks and airports, and those used for industrial activity generally produce some form of pollution that is carried off the surface with precipitation generated water runoff. The pollutants carried off the surface can pollute the catchment, or, to mitigate this, require the treatment of large quantities of surface water with relatively low pollution levels with an associated cost

generally in proportion to the volume. Spillages of chemicals over the surface may also run off the pavement and into the adjoining aquatic environment and cause pollution if no spillage closed containment storage is provided by the pavement drainage.

Prior Art Solutions

Professor Pratt of Coventry University has described a paving system for spillage and flood management in WO96/12067, equivalent to GB-A-2294077 and US-A-6146051. This system is an example of an infiltration basin and uses a perforated pavement that covers a deep substrate of mainly hard nodules or shells, which is contained within impervious walls in order to form a tank. Water is stored within the substrate and can be discharged from an outlet in the base of the tank.

The Pratt tank reduces peaks in the outlet flow and also enables the chemical or biochemical treatment of spillages within the substrate.

Structural components for the assembly of a SUDS system for use with a permeable pavement include synthetic geocellular structures such as those available from SEL Environmental under the trade marks PERMAVOID (R.T.M.) for perforate, polypropylene box units and PERMACEPTOR for an interception, attenuation and treatment facility.

These systems all envisage the use of a permeable pavement and some form of outlet to the natural aquatic environment.

The role of evaporation in the disposal of rainwater has also been considered by Professor Pratt in a paper given to The Chartered Institution of Water and Environmental Management Midlands Sustainable Urban Drainage Systems Symposium part 2 on 31 January 2001, in which it is acknowledged that field data generated by Mantle in 1993 (in an unpublished thesis at Nottingham Trent University entitled "On Site Reduction and Attenuation of Urban Stormwater Runoff") has shown that a permeable pavement construction may evaporate significant amounts of water.

Evaporation as a method of disposing of treated waste water is described in US4039451 (Smith Alvin Jack). However this is a system to which a supply of water is separately piped rather than being located beneath a pavement. The described evaporation bed has an exposed surface.

Solution of the Invention

In accordance with the present invention it has been appreciated that by enhancing evaporation it is possible to create a system that can be designed without an outfall in order to eliminate surface water runoff contribution to flooding or pollution of the adjoining catchment. With an outfall, the system of the invention can minimise storm flows to adjoining receiving waters and reduce the volume of polluted runoff that requires disposal.

The present invention provides a storage cell for receiving water from a pavement defining an upper boundary of the cell, a remaining boundary of the cell being defined by means of a water impermeable layer, characterised in that the cell further comprises means for taking water from a lower part of the cell and enhancing its evaporation.

Preferably the evaporation enhancement means comprises an array of wicks depending into the water normally stored within the lower part of the cell and lifting it into an upper part normally above the water level.

Preferably the wicks are made of capillary matting.

In a preferred embodiment at least two air vents are provided to enable air to flow across the wicks within the cell.

If the pavement is porous at least some of the wicks may contact a layer of matting beneath a wearing course of the pavement.

Chemical spillage on the surface is fully contained by the system and may be removed by lifting the polluted water out by pumping following the incident or, if acceptable, by later removal when the polluted water volume in the cell has been reduced by evaporation. Providing a plurality of discrete cells underneath a large pavement or

dividing a cell into a number of discrete units with individual draw off points may be desirable to contain any spillages within the smallest volume of stored water.

Accordingly an embodiment of this system can provide below-pavement storage of surface water arising from the surface that is reduced in volume by evaporation that is enhanced or increased by wicks within the ventilated storage cell(s). Rainfall, which lands on the surface, is drained to a structural voided storage cell below the pavement, which overlays a water retaining impermeable liner supported by adjacent soils (or structure), or, which overlays a water retaining structure. The stored water within the cell is disposed of primarily by the action of evaporation from the impounded water surface and from wicks inside the cell that extend above the normal impounded water surface, assisted by ventilation to lower the air saturation level of the air within the cell.

Periodically, water that remains unevaporated and contains pollutants is drawn off and this smaller quantity of distillate containing a higher level of pollutants is disposed of by an appropriate treatment process.

The system can be designed to have no outfall to the adjoining aquatic environment.

Brief Description of the Drawings

In order that the invention may be well understood two embodiments thereof will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 shows a vertical section through a first embodiment of a system in accordance with the invention with a permeable pavement;

Figure 2 shows a vertical section through a second embodiment of a system in accordance with the invention with an impermeable pavement; and

Figure 3 shows a possible plan layout of wicks within a storage cell for use in either embodiment.

Overview

A water storage cell 3 is positioned underneath a pavement 1. An upper boundary of the cell 3 is formed by a surface or wearing course of the pavement. The remaining boundary of the cell is defined by a water-impermeable layer 4. The cell is filled with civil engineering materials typically used in the layers of a load-bearing pavement selected to leave a significant void volume to accommodate the drained water, which will typically fill the cell to a level 5. An array of wicks 6 depends from an upper part of the cell into a lower part below the water level 5 to enhance evaporation. Air inlet/outlets 7 are provided to increase ventilation and further enhance water evaporation.

The cell 3 can be used in a SUDS system without an outfall with both permeable and impermeable pavements.

Detailed Description of a Preferred Embodiment

In Figures 1 and 2 the Activity Duty Pavement 1 supports the desired human activity (e.g. vehicles in a car park) and is designed to pavement engineering design standards to be structurally adequate for the desired design life of the pavement. In Figure 1 the Activity Duty Pavement 1 is permeable (e.g. porous asphalt or permeable block paving) and when precipitation occurs the rainwater infiltrates through the surface and into the Structural Voided Storage Cell 3 which is a structure with a high void proportion and low percentage of structural elements with significant opening for ventilation that is structurally designed to be capable of supporting the Activity Duty Pavement 1. In Figure 2 the Activity Duty Pavement 1 is impermeable and is designed to fall to Drainage Gullies or Channels 2 which link to the Structural Voided Storage Cell 3. Drainage Gullies or Channels 2 should ideally have grit traps to minimise the amount of fine material passing in suspension into the Structural Voided Storage Cell 3, which would reduce the storage capacity. Oil traps in the Drainage Gullies or Channels 2 would also be beneficial for ease of regular removal of small quantities of spilt oil (if associated with the activities that occur on the pavement).

The entry of water into the Structural Voided Storage Cell 3 laid within an

Impermeable Liner 4 creates a Stored Water Surface Level 5. Wicks 6 are fixed vertically in the Structural Voided Storage Cell 3 and are made of durable capillary mat textile and extend from the Impermeable Liner up to the underside of the Activity Duty Pavement 1 and in the case of a permeable pavement in Figure 1 the wick material may extend horizontally over the whole base area of the pavement to enhance evaporation up through the permeable pavement when capillary action saturates the mat during water levels within the mat's capillary lift height. This horizontal mat is provided with sufficient perforations to provide free drainage down through the pavement at times of design peak intensity rainfall. With multi-cell systems the water level may be raised (e.g. by pumping between cells) in certain cells to take advantage of increased evaporation when the horizontal mat is saturated. Additionally, multi level cells that store water as close to the pavement surface as possible to keep the horizontal mat saturated for as much time as possible may be adopted. These wicks will by capillary action draw water up above the Stored Water Surface Level 5 and increase the effective area for evaporation. The Wicks 6 may be made of a sandwich of outer capillary geotextile enclosing a fine inert material (e.g. fine graded sand or powder) increasing the capillary action lift height. Evaporation is increased by the through flow of air, which is increased by the provision of Air Vents 7. The Air Vents 7 may be taken above ground level to increase their wind draw and they may be topped with cowls that are designed to increase the draw created by wind. Forced ventilation of larger cells may be desirable.

Figure 3 shows a suggested plan layout for the capillary wicks that allows through airflow. The spacing of the Wicks 6 should be set to optimise the wick area for evaporation and is dependant on the capillary action lift height of the chosen wicks. For example if Wicks 6 with a capillary action lift height of 300mm are 150mm wide and spaced at 300mm centres in each direction the effective wick surface evaporation area will equal the water surface area.

The effect of evaporation is to reduce the stored volume of polluted water. When the distillate becomes significantly polluted it may be drawn off (e.g. by pump or valve controlled gravity draw off point) for disposal via an appropriate treatment process.

Ideally this draw off should be at a time of minimum storage (such as the end of summer) to minimise the quantity of water for treatment.

Evaporation may also be increased by artificial means such as warming the stored water or mechanically forcing the ventilation.

Where the system is designed to store rainfall which is excess to the level of evaporation over the course of the design year (taking into account the climate of the locality and the amount of pavement and stored water evaporative surfaces and wick area) no outfall is required. The system should be designed to ensure that the Stored Water Surface Level 5 is maintained under design storage levels below the lowest point of a top edge of the cell's Impermeable Liner 4. Pavements incorporating granular materials should not be flooded when in duty service. In some climates there will be an excess of water over evaporation annually, which will be required to be drawn off in some, or all years, via an Extraction Well 9. Design should include an allowance over the design life for any fine materials that will ingress into the Structural Voided Storage Cell 3 and reduce the effective storage capacity. Allowance should also be made in the design for any change in evaporation from the wicks due to biofilm growth. Where desirable, the depth of the Structural Voided Storage Cell 3 can be minimised by extending the cell beyond the extent of the paved surface to create an Extended Storage Cell 3 contained at the periphery of the pavement provided it is enclosed within the impermeable liner 4. The adjoining surfaces should not be designed to contribute surface water to the system Activity Duty Pavement 1, unless accounted for in the evaporative system design.

If desired the liner (or water retaining structure) may be laid to drainage falls towards the Extraction Well 9 to aid full draw off of distillate.

Claims

1. A storage cell for receiving water from a pavement defining an upper boundary of the cell, a remaining boundary of the cell being defined by means of a water impermeable layer, characterised in that the cell further comprises means for taking water from a lower part of the cell and enhancing its evaporation.

2. A storage cell as claimed in claim 1, wherein the evaporation enhancing means comprises an array of wicks depending into the water normally stored within the lower part of the cell and lifting it into an upper part normally above the water level.

3. A storage cell as claimed in claim 2, wherein the wicks are made of capillary matting.

4. A storage cell as claimed in claim 2 or 3, wherein at least two air vents are provided to enable air to flow across the wicks within the cell.

5. A storage cell as claimed in any one claims 2, 3 or 4, wherein the pavement is porous and at least some of the wicks contact a layer of matting beneath a wearing course of the pavement.

6. A storage cell as claimed in any one of the preceding claims, wherein there is no outfall from the cell.

7. A storage cell as claimed in any one of the preceding claims, wherein the water impermeable layer is formed by means of a liner supported by adjacent soil.

8. A storage cell as claimed in any one of claims 1 to 6, wherein the water impermeable layer is a tank wall

9. A storage cell substantially as herein described with reference to Figure 1 or 2 and Figure 3 of the accompanying drawings.

Abstract

Sustainable Surface Water Disposal System

A water storage cell (3) is positioned underneath a pavement (1). An upper boundary of the cell (3) is formed by a surface or wearing course of the pavement. The remaining boundary of the cell is defined by a water-impermeable layer (4). The cell is filled with civil engineering materials typically used to support a load-bearing pavement selected to leave a significant void volume to accommodate the drained water, which will typically fill the cell to a level (5). An array of wicks (6) depends from an upper part of the cell into a lower part below the water level (5) to enhance evaporation. Air inlet/outlets (7) are provided to increase ventilation and further enhance water evaporation. The cell (3) can be used in a SUDS system without an outfall with both permeable and impermeable pavements.

(Figure 1)

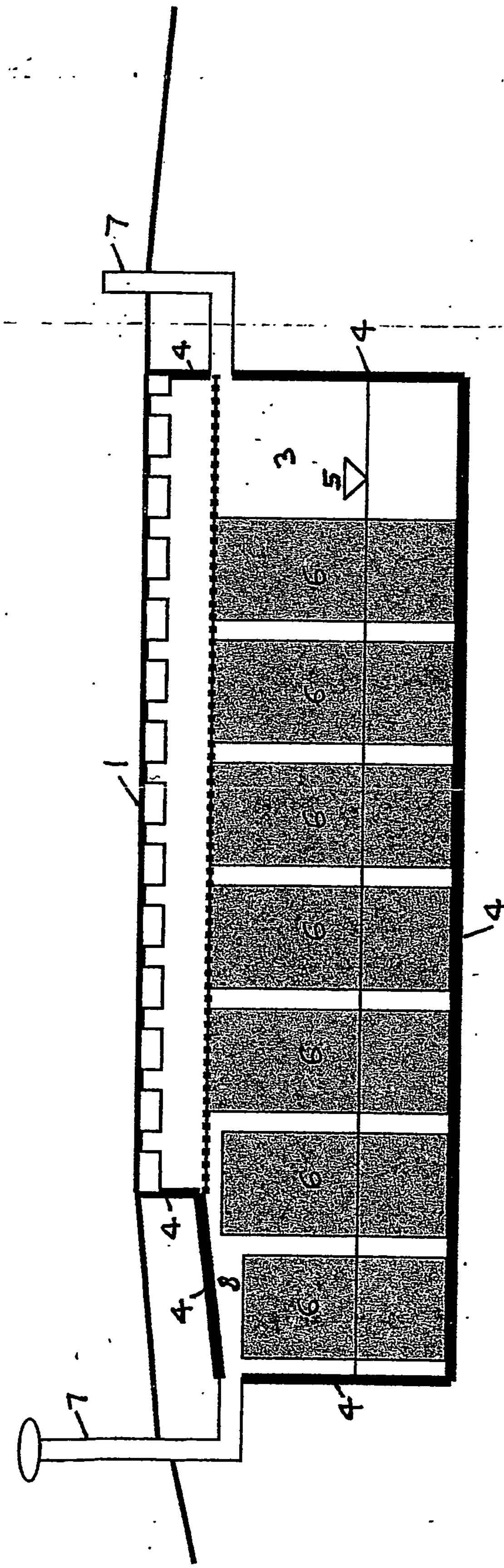

FIGURE 1

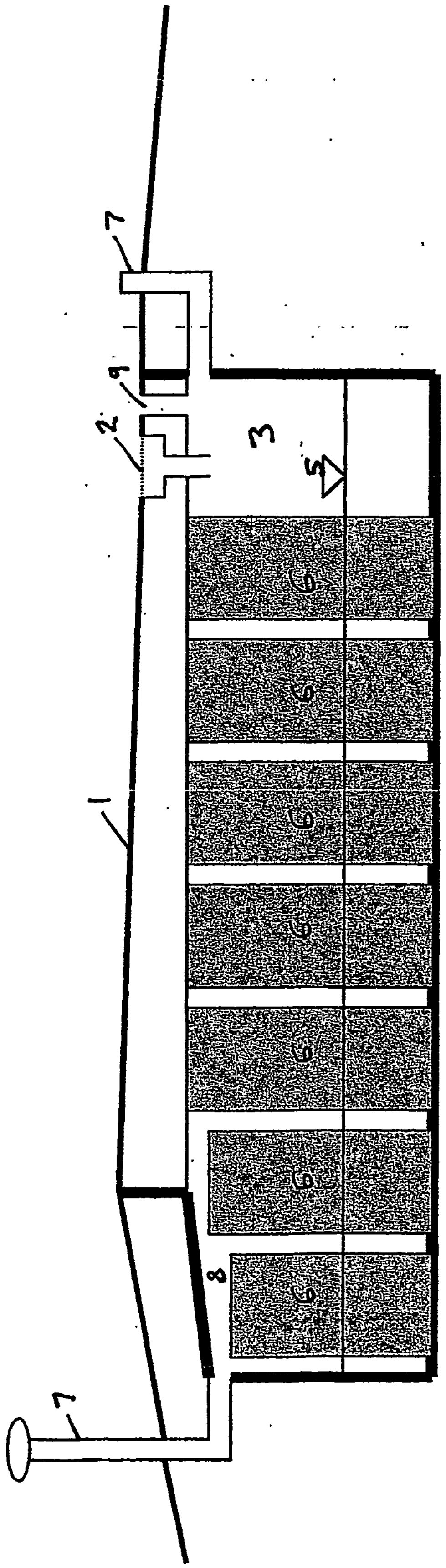

FIGURE 2

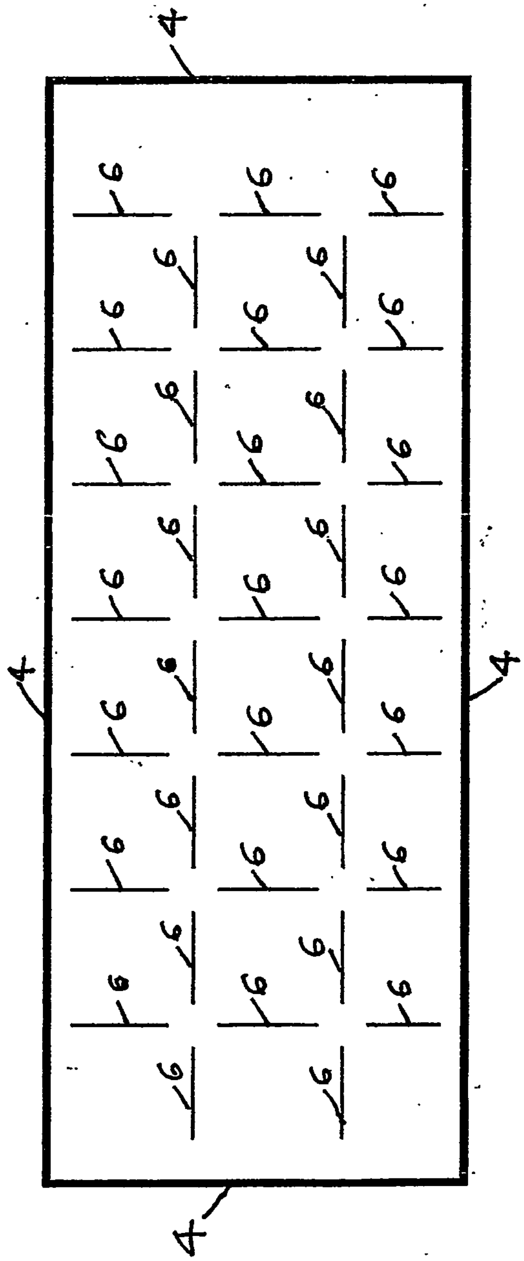

FIGURE 3